AVLIS Enrichment of Medical Isotopes

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Under the sponsorship of the United States Enrichment Corporation (USEC), we are currently investigating the large-scale separation of several isotopes of medical interest using Atomic Vapor Laser Isotope Separation (AVLIS). This work includes analyses and experiments on the enrichment of 203Tl as a precursor to the production of 201Tl used in cardiac imaging following heart attacks, on the stripping of 84Sr from natural strontium as a precursor to the production of 89Sr for the relief of pain due to bone cancer, and, in a related industrial application, on the stripping of radioactive 210Pb from lead used in integrated circuits to reduce the number of alpha particle induced logic errors.

In the AVLIS process, metal atoms are vaporized from a heated crucible and allowed to expand into vacuum. The low-density vapor is illuminated by multiple laser colors which resonantly excite and then photoionize the atoms. The lasers are set at precisely controlled frequencies and have sufficiently narrow frequency bandwidths so that only the isotope of interest is ionized. The enriched ions are electrostatically separated from the resulting plasma and condensed.

All rights to AVLIS technology previously owned by DOE have been transferred to USEC. Presently a government corporation, USEC has submitted a privatization plan to the President and Congress and expects approval in 1996. The USEC Board of Directors decided in 1994 to proceed toward construction of an AVLIS plant for uranium enrichment. Although the focus of the AVLIS program has been and remains the enrichment of uranium for commercial nuclear reactors, USEC plans to commercialize other promising applications of AVLIS technology, including the enrichment of medical isotopes.

The determination of whether AVLIS can be used to practically enrich a particular isotope for medical use involves three steps. First, a spectroscopically selective photoionization pathway needs to be discovered. Unlike mass spectrometric enrichment methods, which can scale from one element to the next in a simple fashion, AVLIS depends on details of the spectroscopy, such as isotope shifts, optical cross sections and state lifetimes, which vary unpredictably from one element to the next. While some of this information is available in the literature, the properties of excited state to excited state transitions generally have to be measured. Second, a gram-scale, proof-of-principle enrichment is performed. A facility to carry out these enrichments is nearing completion at LLNL. It consists of a flexible laser system, a separator vessel of tested design, and safety systems which permit the handling of heavy metals. Given the correct application and business opportunity, the facility can

separate isotopes on a kilogram per year scale. Third, information from the first two steps is used to design a production scale enrichment cascade and to evaluate the cost for AVLIS enrichment of the isotope. USEC will use these costs, along with its determination of the size and composition of the potential market, to decide if any particular isotope warrants production.

FY96 plans call for completion of spectroscopic experiments on Tl and Pb, and for gram scale separation of one of these elements.

This work was performed under the auspices of the U.S.Department of Energy by Lawrence Livermore National Laboratory under contract no. W-7405-Eng-48.